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CANADIAN PATENT

PROCESS FOR MANUFACTURING MOLDABLE FIBROUS PANELS

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No. OF CLAIMS 4

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The present invention relates to the production of a self-supporting mat comprising fibers and binder material which can be compressed, shaped or formed to a permanent, rigid pre-determined contoured article.

5 Heretofore, moldable preforms of fiber binder composition have been made by a continuous process of air-laying the fibers and binder composition to form a felt upon a foraminous screen. The low density mat (1 to 3 pounds per cubic foot) is then pre-pressed to condense the mat to a density wherein it is
10 handleable and transportable upon a caul. The mats are then individually handled and stacked until ready for entry into a multiple opening flat platen press for consolidation to a self-supporting mat structure.

 The present invention avoids the above described
15 combination of continuous and batch handling. It permits the practice of a continuous process from air-laying of fiber to emergence of a self-supporting fiber panel. Thus, the provision and the handling of cauls is eliminated. The costly platen hot press and the handling required therefore is eliminated, as well
20 as other incidental labor and equipment used as a result of platen-pressing. The present invention permits a much greater production rate than the platen-pressing system with an appreciable reduction in capital expenditures. It permits of a more controllable system and thus a more uniform product.

25 It is an object of this invention to provide a process for the formulation of a moldable fibrous mat of uniform thickness and density.

 A further object of this invention is the provision of a continuous process for forming moldable fibrous mats having
30 both uniform density and uniform thickness.

 An additional object of this invention is the provision of a continuous process for the formation of a low-density fibrous mat having a binder therein and the transformation of this mat

to a moldable fibrous mat having uniform density and uniform thickness.

In carrying out the invention a mat comprising fiber and binder is formed by pneumatic deposition on a foraminous conveyor, or wire screen, such as is commonly used in some continuous air-laying processes. Such deposited mats frequently have an irregular surface, which if the mat is consolidated to a uniform thickness will result in non-uniform density. Accordingly, to insure having moldable panels of uniform density and uniform thickness it is desirable to pass the felted mat through a scalping station where one or more scalping rolls remove the top layer of the mat to form a level felted mat of uniform thickness and density. The leveled mat and its conveyor may then be passed through one or more sets of compression rolls to initially reduce the original thickness and increase the original felted density to a range of 4 to 10 pounds per cubic foot.

With or without the above initial pre-pressing step, the mat and its conveyor next are passed through a conditioning stage which quickly raises the temperature of the mat to a temperature in the range of 90°F to 200°F preferably in the range of 115°F to 150°F. The conditioning stage comprises chambers opening close to the two faces of the mat, which chambers contain a heating gaseous fluid such as steam or hot air.

The moisture content of the heated mat leaving the heating stage is important as well as the temperature and should be within the range of 8-15%. Sufficient moisture in combination with heat is required to adequately plasticize the fibers for effective consolidation but not so great as to cause subsequent sticking to the compression rolls resulting in soft or fuzzy surface panels.

The time of exposure is important so as not to dry out the surfaces, or set up thermosetting resins when present, while

attaining the internal temperature and moisture content desired. For this reason, the mat should be sufficiently open and porous for the heating fluid readily to diffuse into it in a very short period of time, such as in the range of from 2 to 20 seconds. It is also preferred that the heating gaseous fluid be applied from both sides of the mat to minimize any tendency of the finished cut panels to be unbalanced or to bow.

For the foregoing reasons, it is preferred to use a steam atmosphere in the conditioning stage as it lends itself more easily to controls for arriving at the desired uniform temperature and moisture content. However, other gaseous fluids may be heated and/or humidified where required to accomplish the same result.

A mat so heated internally and with a moisture content of 8% to 15% may be immediately cold roll pressed at pressures of from 100 to 500 pounds per lineal inch to a density in the range from 30 to 60 pounds per cubic foot, and on removal of the compression force, substantially retain that density. In some instances, particularly in providing moldable panels in the higher density range for certain uses, it may be advantageous to pass the felted mat through multiple stages of steaming and roll pressing while maintaining the above mentioned moisture content and pressure limitations. Thus, this invention permits the manufacture of a continuous self-supporting moldable fibrous panel structure by a continuous process including in a series the steps of pneumatic deposition, initial light compression, treatment by hot gaseous fluid, and cold rolling compression, followed by uncompressed cooling.

The fiber is preferably wood fiber, although other fibers both organic and inorganic may be combined therewith. The resin may be thermoplastic or thermosetting or a combination of the same. The composition of the board with respect to fiber and the types of resin may vary greatly. Typical resins that may be used are phenol-formaldehyde resin, wood rosin, polyvinyl acetate, paraffin, and neoprene. From 1 to 30%, on an oven dry solids basis, of

these resins either singly or in combination may be mixed with the fibers.

When wood is defibered by the Asplund defibrator in a high-pressure steam chamber, the thermoplastic resin and the thermosetting resin may be incorporated with the fibers by introducing the resins into the stream of fiber and steam which emerges from the defibrator, as described in the following Heritage U. S. Patents: Nos. 2,940,134; 2,757,115; 2,757,148; 2,757,149; and 2,757,150 (which also disclose pneumatic deposition of fibers).

As described in said patents, the fiber is conducted rapidly in conduits and in transit is reduced in its moisture content to a desired level. For the present invention, a moisture content in the range from 8% to 18% (oven dry basis) is desired for felting the fiber, and it has been found that in the range from 11% to 14% (oven dry basis) the roll pressure required for the final compression is the least.

The continuous process above-described may be carried out in apparatus such as shown in the accompanying drawing, in which the apparatus is schematically illustrated.

In the drawing, a supply 10 of fiber and resin, which has been mixed by known methods, is fed to a suitable air-laying felter 12 through which travels an endless conveyor 14 of open-mesh screen. Scalping means 13, if employed, is a part of the felter system, from which scalped material is returned to the incoming supply as indicated at 15. A resulting level felt 16 having a low density of approximately 2 pounds per cu. ft. is compressed by a pair of rolls 17 and 18 to a density of 4 to 10 pounds per cu. ft. The compressed web 20 moving at up to 100 feet per minute passes through a steam environment, which effects an adequate steaming.

The steam environment is shown as provided by steam chambers having perforated plate faces spaced apart to permit the conveyor 14 and mat 20 to pass through with a minimum of clearance.

Chamber 22 over the top of mat 20 receives steam by inlet 24, and it is positioned within an exhaust hood 26 which extends in both directions away from the chamber 22 in the direction of travel of the web. Chamber 28 receives steam at inlet 30 and opens
5 immediately adjacent the underside of conveyor 14. It is understood that chamber 22 and exhaust hood 26 may be so constructed that they can be raised or lowered to accommodate various mat heights.

The web then immediately enters a pair of unheated press
10 rolls, designated 32 and 34. These are large in diameter to receive a thick mat and to effect a large decrease in its thickness. For example, steel rolls 24 inches in diameter will receive a mat 7 inches thick with a density of 4 to 10 pounds per cu. ft. and reduce it to a thickness in the range from 1/16 to 1 inch. As the
15 mat 20 is of uniform density and thickness as it enters the unheated press rolls, the final moldable panel of desired density is easily obtainable by setting the rolls at a fixed thickness nip and applying sufficient pressure to maintain that setting.

Depending upon the composition of the fibrous structure,
20 its moisture content and internal temperature and upon the density and thickness desired in the moldable panel, the pressure required at the final roll pressing may vary from 100 to 500 pounds per lineal inch.

A minimum pressure of 100 pounds per lineal inch is
25 required to substantially maintain the compressed density of the panel after leaving the rolls while a maximum pressure of 500 pounds per lineal inch avoids any tendency to disrupt the structure of the mat as originally felted or to weaken the individual fibers which might result in faults in the finished molded article or
30 even prevent the successful shaping of the final article due to fracturing while forming in matched dies.

The conveyor 14 is separated from the mat 20 just before the mat enters the unheated press rolls, as shown by the return

idler rolls designated 36-37-38.

The compressed mat 40 from the press rolls rides onto a coarse-mesh endless screen conveyor 42 for carrying the mat through drying and cooling stations when it is desired to hasten the reduction of moisture content to or toward equilibrium with the atmosphere.

Because the compressed mat 40 is to a degree porous, it passes over a suction box 44 connected to a suction fan 46, opposite a heated air chamber 48 above the mat 40. A steam coil 50 in the chamber heats air drawn from the atmosphere by fan 46 through the mat 40.

In order to hasten the cooling of the compressed mat 40 to or toward normal temperature a second suction box 52 connected to suction fan 54 draws atmospheric air through the mat. Then the finished self-supporting compressed mat passes through a cross-cut station (not shown) to sever it into units of desired length.

Moldable panels produced by the process herein described are uniform in structure and content, whereas in hot platen pressing to produce similar panels, surface densities are higher than internal densities frequently appearing as surface skins due to the longer exposure of the surface to the heat of the platens. Also, where part of the binder is thermosetting resin, it is difficult to control the platen-pressing to achieve the desired heating and compression and not at the same time partially react the thermosetting resin.

Furthermore, in platen pressing, particularly in pressing large panels, it is practically impossible to maintain the faces of the press platens consistently parallel to each other over their entire surface. This unevenness is further complicated by the practical limitations in maintaining the carrying cauls completely flat and parallel to the press platens due to their being constantly handled. All of these problems add to the

difficulty of providing moldable panels of uniform density and thickness of structure.

Production control figures sharply point this out wherein moldable fiber panels made by prior procedures using a platen press resulted in panels having a thickness deviation of as much as 11.8% within a panel with the most uniform panels having a thickness deviation of 9.3% within the panel. The panels produced by the process of this invention have a thickness deviation of less than .025% within a single panel and from panel to panel.

Non-uniform areas of density and thickness associated with moldable panels of prior methods are accentuated when shaped in matched dies, necessitating many rejects after costly processing. The moldable panels produced by the process herein described easily can be further processed by shaping or forming in matched metal dies to provide densified rigid articles for ~~commercial~~ applications, such as tote boxes, luggage shells, contoured door panels for automobiles, and contoured chair bodies. Thus, the process of the present invention not only provides a moldable panel of uniform density, thickness and structure, but provides successive panels of the same controllable consistent uniformity of structure and content from face to face.

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CLAIMS:

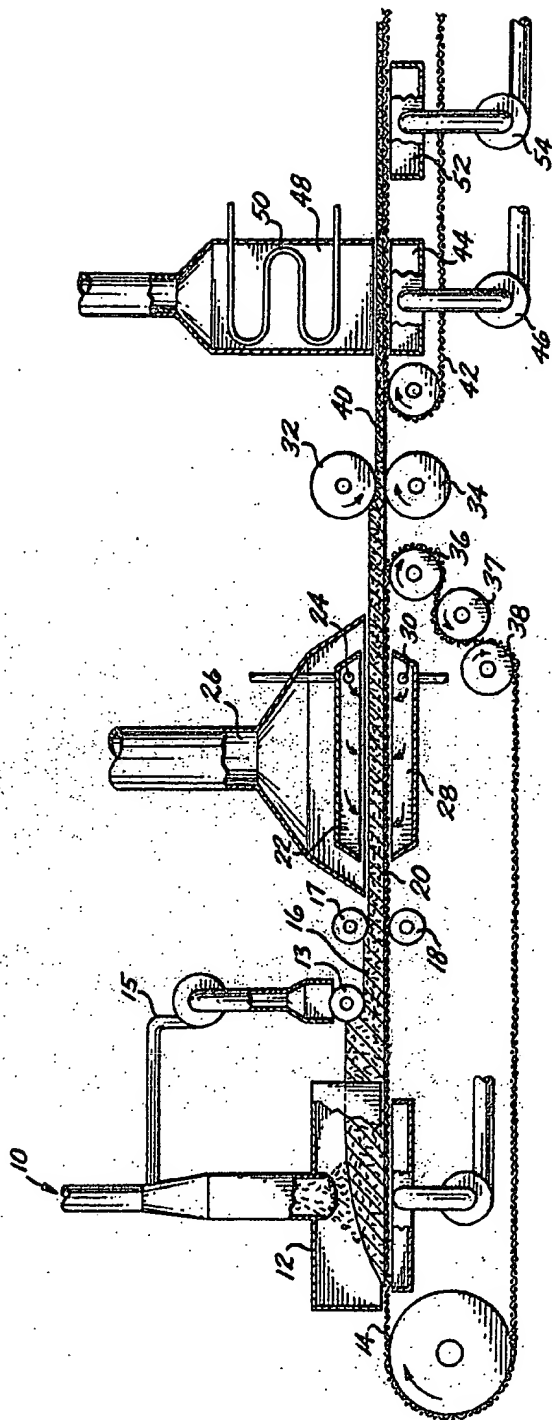
1. The method of forming a moldable rigid felted fiber panel of uniform density, thickness and structure which comprises continuously pneumatically depositing and felting on a moving foraminous conveyor the solid contents of an air-suspension comprising feltable fibers and a resinous binder and thereby forming a mat having a density in the range from 1 to 3 pounds per cubic foot; removing the non-uniform top surface of the mat, pressing the remainder of said mat to a density in the range of 4 to 10 pounds per cubic foot, conditioning said pressed mat by subjecting the two faces of the mat to a hot gaseous environment for a time sufficient to adjust the moisture content in the range of from 8-15% and the internal temperature in the range of 90° F. to 200° F., separating the heated mat from the conveyor, compressing the resulting moving heated mat containing resinous binder to a structure of uniform thickness and uniform density of at least 30 pounds per cubic foot by passing the mat through the nip of cold pressing rolls having a pressure of from 100 to 500 pounds per lineal inch, immediately cooling the resulting compressed panel to approximately room temperature to set the panel structure.

2. The method of Claim 1 wherein the resinous binder comprises a mixture of thermosetting and thermoplastic resin.

3. The method of Claim 1 wherein the internal temperature is adjusted in the range of 115° F. to 150° F.

4. The method of Claim 1 wherein the gaseous environment is steam.

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